CLAIMS

What is claimed is:

1. A photoelectrode comprising a semiconductor layer having a first major surface in contact with an electrically conductive substrate, a second major surface in contact with a transparent, electrically conductive metal oxide (TCO) layer, a transparent, electrically conductive doped tin oxide (SnO_2) layer adjacent said second major surface, said doped SnO layer arranged in electrically conductive contact with said TCO layer.

2. The photoelectrode of Claim 1 wherein said doped SnO_2 layer consists essentially of flourine doped tin oxide (SnO_2:F).

3. The photoelectrode of Claim 1 wherein said doped SnO_2 layer and said TCO layer are spaced apart from one another and an electrically conductive material is arranged to contact both said doped SnO_2 layer and TCO layer, providing electrical contact therebetween.

4. The photoelectrode of Claim 3 wherein said electrically conductive material comprises conductive metal-epoxy sealant.

5. The photoelectrode of Claim 3 wherein an impervious insulative material overlies said electrically conductive material.

6. The photoelectrode of Claim 1 wherein said doped SnO_2 layer directly overlies said TCO layer thereby providing said electrically conductive contact.

7. The photoelectrode of Claim 1 wherein said doped SnO_2 layer is co-extensive with said TCO layer.

8. The photoelectrode of Claim 1 wherein said doped SnO_2 layer is disposed on a non-conductive transparent substrate and said non-conductive transparent substrate is arranged between said TCO layer and said doped SnO_2 layer.

9. The photoelectrode of Claim 8 wherein an electrically conductive material is disposed on a peripheral surface of said transparent substrate and in contact with said TCO and doped SnO_2 layers.

10 . The photoelectrode of Claim 1 wherein an impervious insulative material overlies peripheral surfaces of said electrically conductive substrate, semiconductor, and TCO layer.

11. The photoelectrode of Claim 1 wherein said electrically conductive substrate has a surface facing away from said semiconductor layer, and an impervious insulative material overlies said facing-away surface.

12. The photoelectrode of Claim 1 wherein said doped SnO_2 layer comprises a transparent substrate having a first major surface facing said TCO and a second major surface opposite said first major surface, a peripheral surface defined by a thickness between said major surfaces of said transparent substrate, doped SnO_2 coated on both major surfaces of said transparent substrate and coated on at least a portion of said peripheral surface between said first and second major surfaces of said transparent substrate, thereby providing said electrically conductive contact between said TCO layer and doped SnO_2 layer.

13. The photoelectrode of Claim 1 wherein said semiconductor layer comprises photovoltaic, amorphous, silicon triple junction material.

14. The photoelectrode of Claim 13 wherein said photoelectrode comprises, in order, said electrically conductive substrate comprising ss/Ag/ZnO and said semiconductor comprising n-i-p; wherein said n-layer faces said ZnO, and said p-layer faces said TCO.

15. The photoelectrode of Claim 1 wherein said TCO layer consists essentially of indium tin oxide (ITO).

16. The photoelectrode of Claim 1, which is a photoanode.

17. The photoelectrode of Claim 3 wherein said metal of said metal-epoxy sealant is selected from one group consisting of silver, nickel, platinum, ruthenium, iridium, iron, iron oxide and alloys thereof and mixtures thereof.

18. A photoelectrode comprising a semiconductor layer having a first major surface in contact with an electrically conductive substrate and a second major surface in contact with a transparent, electrically conductive doped tin oxide (SnO_2) layer; wherein said semiconductor layer comprises photovoltaic, amorphous, silicon n-i-p material having said doped SnO_2 layer in contact with p of said n-i-p.

19. The photoelectrode of Claim 18 wherein said doped SnO_2 layer consists essentially of fluorine doped tin oxide (SnO_2:F).

20. The photoelectrode of Claim 18 wherein said semiconductor layer comprises a-Si-nip/nip/nip triple junction material.

21. The photoelectrode of Claim 18 wherein said photoelectrode comprises, in order, said electrically conductive substrate comprising ss/Ag/ZnO and said semiconductor comprising n-i-p; wherein said n-layer faces said ZnO, and said p-layer faces said TCO.

22. A photoelectrochemical device for electrolysis of water to produce hydrogen comprising:

a container housing a photoelectrode, a counter electrode and an electrolyte solution, said photoelectrode and said counter electrode spaced apart from one another in said container and each being in contact with said electrolyte solution;

a photoelectrode comprising: a semiconductor layer having a first major surface in contact with an electrically conductive substrate and a second major surface coated with a first conductive layer; said first conductive layer comprising a first metal oxide which is transparent, anti-reflective and electrically conductive; a second conductive layer comprising a second metal oxide which is transparent and electrically conductive; said second conductive layer adjacent to said second major surface and arranged in electrically conductive contact with said first conductive layer; and said second conductive layer being more stable in basic solutions than said first conductive layer;

said counter electrode comprising a metal;

said solution comprising a solvent which comprises water and a solute which comprises a base; and

an electrically conductive path between said photoelectrode and said counter electrode.

23. The photoelectrochemical device of claim 22 wherein said metal of said counter electrode is stable in basic solution and has a low overvoltage for the hydrogen evolution reaction.

24. A photoelectrode comprising: a semiconductor layer having a first major surface in contact with an electrically conductive substrate and a second major surface coated with a first conductive layer; said first conductive layer comprising a first metal oxide which is transparent, anti-reflective and electrically conductive; a second conductive layer comprising a second metal oxide which is transparent and electrically conductive; said second conductive layer adjacent to said second major surface and arranged in electrically conductive contact with said first conductive layer; and said second conductive layer being more stable in basic solutions than said first conductive layer.

25. The photoelectrode of Claim 24 wherein said first conductive layer consists essentially of indium tin oxide (ITO).

26. The photoelectrode of Claim 24 wherein said second conductive layer comprises fluorine doped tin oxide (SnO_2:F).

27. A photoelectrode comprising a semiconductor layer having a first major surface in contact with an electrically conductive substrate, a second major surface in contact with a transparent, electrically conductive metal oxide (TCO) layer, and a peripheral, surface defined by a thickness between said major surfaces of said semiconductor layer;

an electrically conductive material in contact with at least a portion of said peripheral surface of said semiconductor layer and in contact with said TCO layer; and

a transparent insulative layer adjacent said TCO layer.

28. The photoelectrode of Claim 27 wherein said insulative transparent layer is spaced from said TCO layer thereby forming a gap and said electrically conductive material fills at least a portion of said gap.

29. The photoelectrode of Claim 28 wherein said electrically conductive material overlies said peripheral surface of the semiconductor layer and overlies at least a portion of a major surface of said TCO layer facing said transparent layer.

30. The photoelectrode of Claim 27 wherein said TCO layer has a major surface facing said transparent layer and has a peripheral surface, and said electrically conductive material overlies at least a portion of said peripheral and major surfaces of said TCO layer.